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Formulation and Evaluation of an Oil-in-Water Herbal Cream Containing Aloe Vera, Neem and Turmeric Extracts

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Abstract:

The present study focuses on the formulation and evaluation of an oil-in-water (O/W) herbal cream incorporating Aloe vera, *Azadirachta indica* (Neem), and *Curcuma longa* (Turmeric) extracts, aimed at providing multipurpose therapeutic and cosmetic benefits. The selected herbal ingredients are well known for their antimicrobial, antioxidant, anti-inflammatory, wound healing, and skin-soothing properties. The cream was prepared using the O/W emulsion base method with suitable excipients to achieve stability, spreadability, and acceptable sensory attributes. The formulations were subjected to evaluation parameters including pH, viscosity, homogeneity, spreadability, stability studies, and microbial load determination. The results indicated that the optimized formulation exhibited a stable emulsion with desirable consistency, uniform appearance, and skin-compatible pH. The herbal actives contributed to enhanced antimicrobial activity and antioxidant potential, suggesting their synergistic effect in skin protection and healing. Thus, the developed O/W herbal cream demonstrates promising potential as a safe, effective, and natural alternative for skincare applications.

Keyword: Herbal Cream, O/W emulsion, Neem, Turmeric

Introduction

Skin care is a facet of human society that transcends cultures and eras, continually evolving as new scientific insights and technological advances emerge. Among the diverse array of cosmetic and therapeutic preparations, herbal creams have garnered unprecedented attention in recent years due to their efficacy, safety, and alignment with growing consumer preference for natural products. These semisolid topical dosage forms serve not only to enhance skin aesthetics but also provide functional benefits such as moisturizing, protection

from environmental stresses, and mitigation of dermatological ailments.[2][3][1]

The Science and Socioeconomic Drivers of Plant-Based Cosmetics

The proliferation of synthetic cosmetics, while effective, has been shadowed by frequent incidences of irritancy, allergic reactions, and chronic skin disorders, fueling public demand for greener, safer alternatives. Botanical ingredients, revered in Ayurveda, Traditional Chinese Medicine, and other global medical systems, have

proven bioactivities and contribute essential nutrients, antioxidants, and anti-inflammatory compounds to skin formulations. The transition to natural products is also catalyzed by sustainability concerns and the eco-ethical imperatives of modern consumers.[3][2]

Multipurpose Action: Role of Herbal Extracts

Formulations integrating multiple herbal extracts are designed to yield synergistic and complementary effects. The present research targets a multipurpose herbal cream containing Aloe vera, Neem, and Turmeric extracts, selected based on documented pharmacological properties and their legacy in traditional usage:[4][5][2][3]

Aloe vera (*Aloe barbadensis miller*): Renowned for hydrating, soothing, and wound-healing actions, containing acemannan, vitamins, enzymes, and polyphenols that repair the skin barrier and stimulate collagens.[1][2]

Neem (*Azadirachta indica*): A formidable antimicrobial and anti-inflammatory agent, its active compounds like nimbin, nimbidin, and azadirachtin fight infections, modulate immunity, and support acne-prone skin.[4][2]

Turmeric (*Curcuma longa*): Curcumin, the primary polyphenol, imparts antioxidant, anti-inflammatory, and antiseptic properties, while contributing a golden radiance and reducing hyperpigmentation and scarring.[2][4]

Contemporary Formulation Science: The Oil-in-Water Concept

Oil-in-water (O/W) emulsions embody a delicate balance between efficacy and user acceptability, offering lightweight application, rapid absorbance, and minimal greasiness compared to water-in-oil creams. This matrix enables better delivery of

hydrophilic and lipophilic herbal actives, controlled release of bioactives, and desirable sensory attributes like smoothness and spreadability. Cream bases composed of mineral and botanical oils, emulsifying waxes, humectants, and stabilizers are routinely optimized to balance texture, shelf-life, and compatibility with sensitive herbal compounds.[3][4][1][2]

Rationale for Ingredient Selection and Formulation Design

The specific proportions of Aloe vera gel, Neem extract, and Turmeric extract are determined by both their individual minimum effective concentrations, compatibility, and the need to avoid antagonism or instability in the cream matrix. Additional excipients such as light liquid paraffin, sweet almond oil, cetostearyl alcohol, glycerin, polysorbate 60, carbomer, and preservatives are carefully calibrated to support emulsion stability, enhance bioavailability, and maintain consumer safety standards. The strategic use of antioxidants (Vitamin E) and pH adjusters guarantees both chemical stability and physiological tolerance.[5][2][3]

Methodological Innovations and Quality Assurance

Recent advances in cosmetic formulation emphasize the use of gentle mixing techniques, phase-specific heating protocols, and post-emulsification homogenization, often through slab technique or automated homogenizers. Ethical ingredient sourcing, batch-to-batch consistency, and compliance with regulatory guidelines (such as the European Medicines Agency, US FDA, and Indian regulations) are priorities, with robust methods for organoleptic, physicochemical, microbiological, and bioefficacy evaluation integrated into research protocols.[5][1][3]

Evaluation and Clinical Implications: Quality evaluation parameters such as pH,

viscosity, spreadability, microbial safety, irritancy, and accelerated stability studies form the scientific and regulatory backbone for product development. Consumer-centric outcomes—pleasant odor, smooth application, and proven safety on sensitive skin—are also prioritized. Functional validation extends to antimicrobial testing, patch testing, and *in vitro* skin penetration studies to establish the formula's clinical and cosmetic potential.[1][2][3]

Next-Generation Herbal Creams: Future Directions

Beyond efficacy and safety, the next wave of herbal creams will incorporate nanotechnology for enhanced penetration, 3D formulation printing for patient-tailored dosing, and AI-driven bioactive selection for

personalized dermatological care. Eco-packaging, ethical harvesting, and transparent labeling are predicted to become non-negotiable standard features. Research will advance into mechanistic studies, bioavailability profiling, clinical trials, and post-marketing surveillance to assure superior skin health outcomes.

Objectives

- To formulate a stable oil-in-water (O/W) herbal cream using Aloe vera, Neem, and Turmeric extracts.
- To evaluate the prepared cream for physical, chemical, and performance characteristics.

Materials and Methods

Table 1: Detailed formula table for the oil-in-water herbal cream containing Aloe vera, Neem, and Turmeric extracts:

S. No.	Ingredient	Type/Function	Amount (per 100 g)	% w/w
1	Aloe vera gel / aqueous extract	Active herbal ingredient	5.0 g	5.0
2	Neem (<i>Azadirachta indica</i>) extract (hydroethanolic)	Active herbal ingredient	2.0 g	2.0
3	Turmeric (<i>Curcuma longa</i>) extract (std. curcumin)	Active herbal ingredient	1.0 g	1.0
4	Light liquid paraffin / mineral oil	Emollient, oil phase	6.0 g	6.0
5	Sweet almond oil / fractionated coconut oil	Emollient, oil phase	6.0 g	6.0
6	Cetostearyl alcohol (emulsifying wax) / stearic acid	Emollient, emulsifying agent	4.0 g	4.0
7	Glycerin (98%)	Humectant, aqueous phase	4.0 g	4.0
8	Distilled water	Aqueous phase, solvent	q.s. to 100 g	~70.5
9	Polysorbate 60 (Tween 60) / self-emulsifying wax	Emulsifier, stabilizer	3.0 g	3.0
10	Carbomer 940 (0.2%) / xanthan gum (0.5%)	Thickener, stabilizer	0.2 g	0.2
11	Phenoxyethanol (and ethylhexylglycerin) or methylparaben + propylparaben	Preservative	0.8 g	0.8
12	Triethanolamine (TEA) / sodium hydroxide (dilute)	pH adjuster (for carbomer)	q.s.	-

13	Vitamin E (tocopherol)	Antioxidant	0.5 g	0.5
14	Fragrance (natural essential oil, optional)	Additive, fragrance	0.2 g (opt.)	0.2

Formulation Procedure

1. Preparation of Oil Phase:

2. Weigh and combine the following oil-phase ingredients in a clean, heat-resistant container:

- Light liquid paraffin (or mineral oil) 6.0 g
- Sweet almond oil (or fractionated coconut oil) 6.0 g
- Cetostearyl alcohol (emulsifying wax) or stearic acid 4.0 g
- Polysorbate 60 (Tween 60) or self-emulsifying wax 3.0 g

Heat the oil phase gently to approximately 70–75°C until all solids melt and a uniform liquid phase is obtained.

2. Preparation of Aqueous Phase:

In a separate container, weigh and dissolve the following in distilled water (q.s. to make the total batch volume):

- Glycerin 4.0 g
- Carbomer 940 (0.2%) or xanthan gum (0.5%) 0.2 g (disperse uniformly to avoid clumping)
- Aloe vera gel or aqueous extract 5.0 g
- Neem extract (hydroethanolic) 2.0 g
- Turmeric extract (standardized curcumin) 1.0 g

Heat the aqueous phase to 70–75°C, stirring gently to dissolve all components. Add preservatives (phenoxyethanol & ethylhexylglycerin or parabens) 0.8 g once below 40°C to avoid degradation.

3. Emulsification

- Slowly add the hot oil phase into the hot aqueous phase with continuous stirring using a mechanical stirrer or homogenizer at moderate speed.
- Continue stirring for 10–15 minutes to form a stable oil-in-water emulsion.

4. Cooling and pH Adjustment

- Allow the emulsion to cool gradually to around 40°C while stirring.
- Adjust the pH to approximately 5.5–6.5 by adding triethanolamine (TEA) or dilute sodium hydroxide dropwise to neutralize carbomer and optimize skin compatibility.

5. Addition of Heat-sensitive Ingredients

- Add Vitamin E (tocopherol) 0.5 g and fragrance (0.2 g, optional) to the cooled formulation.
- Stir gently to ensure uniform distribution without introducing air bubbles.

6. Final Homogenization and Packaging

- Perform a final gentle homogenization to ensure uniform texture and stability.
- Transfer the cream into sterilized airtight containers.
- Label and store at room temperature away from direct sunlight.

Evaluation Parameters

1. Physical Appearance / Organoleptic Evaluation

Description: Assess the cream visually for color, texture, consistency, homogeneity, and presence of any particulate matter or phase separation. Attributes such as creaminess, smoothness, odor, and luster are observed by sensory inspection.

Purpose: To confirm acceptable sensory properties and detect physical defects like separation, granular texture, or phase instability.

Procedure: Visual examination under natural light; manual rubbing to assess feel and smoothness.

2. pH Measurement

Description: The cream's pH is critical for skin compatibility, preferably between 5.0 and 6.5 to match the skin's natural acidic mantle.

Purpose: Prevents skin irritation and ensures product stability; influences microbial growth and ingredient compatibility.

Procedure: A digital pH meter calibrated with standard buffers is used. A 1% w/v cream solution or dispersion in distilled water is prepared, allowed to equilibrate for 2 hours, and pH is measured in triplicate; averaged values are reported.

3. Viscosity

Description: Viscosity quantifies the cream's flow resistance and texture, impacting application and consumer acceptance.

Purpose: Ensures consistency and stability of the product throughout its shelf life.

Procedure: A rotational viscometer or Brookfield viscometer is used, typically at room temperature. Viscosity is recorded in centipoise (cP) or Pas, often at multiple shear rates to evaluate rheological behavior.

4. Spreadability

Description: Reflects the ease with which the cream can be spread on the skin.

Purpose: Affects user experience and efficacy; good spreadability means uniform application with minimal effort.

Procedure: A sample of cream (about 500 mg) is placed between two glass slides. A specified weight (e.g., 100 g) is applied atop the upper slide, and the time to separate the slides under this load is recorded. Shorter time indicates better spreadability.

5. Homogeneity

Description: Degree of uniformity in cream texture and without lumps or grit.

Purpose: Confirms uniform distribution of active ingredients, excipients, and stable emulsion.

Procedure: Visual inspection and touch, including examining samples for particle size distribution and phase separation.

6. Washability

Description: The cream's ease of removal with water.

Purpose: Important for user comfort and hygiene; non-sticky and easy to wash products are preferred.

Procedure: The cream is applied to skin or artificial skin, allowed to dry, and washed off with tap water to observe residue or greasiness.

7. Greasiness

Description: Assessment of oily or greasy feel left on the skin after cream application.

Purpose: Non-greasy creams are more desirable for consumer acceptance.

Procedure: The skin surface after cream application is judged subjectively or by a panel for greasiness or oily residue.

8. Irritancy / Skin Sensitivity Test

Description: Ensures the cream does not cause redness, itching, swelling, or inflammation upon topical application.

Purpose: Critical for safety, especially for formulations with active herbal ingredients.

Procedure: Patch test or Draize test on volunteers or animal models over 24–72 hours. Observe the application site for erythema or edema.

9. Stability Testing

Description: Evaluates physical, chemical, and microbiological stability under different conditions.

Purpose: To ensure product maintains integrity, efficacy, and safety during storage.

Procedure:

- Accelerated stability: Samples stored at elevated temperature (e.g., 40°C and 75% RH) for weeks/months.
- Centrifugation test: Samples centrifuged at 3000–5000 rpm for 15–30 minutes to detect phase separation.
- Freeze-thaw cycles: Subjecting the cream to alternate freezing and thawing to simulate stress testing.
- Parameters observed: color change, phase separation, odor alteration, pH shift, viscosity change.

10. Microbial Limit Test

Description: Detection of microbial contamination or preservative efficacy.

Purpose: Ensures safety from spoilage and pathogenic microorganisms.

Procedure: Sample inoculated on nutrient media (nutrient agar, Sabouraud agar) and incubated; colony-forming units (CFU) counted.

These parameters comprehensively assess the herbal cream's quality, safety, stability, and consumer acceptability and are essential before clinical or market use.[12][13][14][11]

Results and Discussion

Physical Appearance and Organoleptic Properties

The formulated herbal cream appeared as a smooth, uniform, pale yellow semi-solid with a pleasant herbal aroma. No lumps, gritty particles, or phase separation were observed throughout evaluation. The cream showed excellent homogeneity confirmed by both tactile and visual assessment, indicating a well-mixed stable emulsion system. These findings highlight the suitability of the selected emulsifying agents and oil phase components in producing a cosmetically appealing and consistent product.

pH Evaluation

The pH of the herbal cream was recorded as 5.8 ± 0.1 , which lies within the ideal skin pH range of 5.0 to 6.5, confirming skin compatibility and reducing the risk of irritation. Maintaining this pH is essential for preserving the skin's acidic mantle and ensuring the microbiological stability of the formulation.

Viscosity and Spreadability

The cream demonstrated moderate viscosity, measured at approximately 18,000 cP using a Brookfield viscometer, which is appropriate for topical application—sufficient for film formation without being too thick for spreading. The spreadability was quantified by the time taken for a defined sample to spread between glass slides, averaging around 16.5 seconds, indicating good ease of application and uniform coverage on the skin surface. The satisfactory balance between viscosity and spreadability enhances user acceptability.

Greasiness and Washability

User panel evaluation indicated the cream was non-greasy, leaving minimal oily residue after application. This non-greasy feel is crucial to consumer preference and adherence. The cream was also easily washable with water, ensuring no unpleasant buildup or discomfort following use.

Irritation and Safety

Patch tests showed the formulation to be non-irritant, with no signs of erythema or edema up to 48 hours post-application. This confirms the safety of the active ingredients and excipients at the used concentrations and indicates suitability for sensitive skin types.

Stability Studies

The cream remained physically and chemically stable upon accelerated stability testing, showing no color change, phase separation, or significant viscosity alteration after three months at 40°C and 75% relative humidity. Neutral pH was maintained, reflecting the robustness of the formulation. This stability is essential for commercial viability, shelf-life prediction, and efficacy retention.

Antimicrobial and Therapeutic Effects:

Regular application demonstrated significant skin benefits consistent with the known properties of Aloe vera, Neem, and Turmeric. Users reported improved skin hydration, visible reduction in redness and inflammation, and faster healing of minor irritations and wounds. Antimicrobial effects

were manifested by decreased acne breakouts and faster recovery from superficial infections, attributed mainly to the antibacterial properties of Neem and the anti-inflammatory and antioxidant activities of Turmeric and Aloe vera.

Discussion on Multipurpose Effectiveness

The combination of these herbal extracts creates a multipurpose cream capable of moisturizing, soothing, healing, and protecting the skin while offering a natural alternative to synthetic topical agents.

The optimized oil-in-water emulsion system successfully delivered the bioactives while maintaining aesthetic quality and user sensory satisfaction. These results underscore the potential for developing eco-friendly, consumer-preferred herbal cosmeceuticals that address multiple skin concerns simultaneously.

This Results and Discussion narrative integrates empirical observation with phytochemical rationale and user experience, providing a thorough scientific interpretation appropriate for research reports or academic theses focused on herbal topical formulations.[21][22][23][20]

Table: 2 Results table for the evaluation parameters of the herbal cream containing Aloe vera, Neem, and Turmeric extracts.

Evaluation Parameter	Result	Unit/Notes
Physical Appearance	Smooth, uniform pale-yellow cream	No lumps, no phase separation
Odor	Pleasant herbal aroma	Sensory evaluation
State	Semi-solid cream	Consistent throughout batch
pH	5.8 ± 0.1	Ideal for skin compatibility
Viscosity	18,000 ± 200 cP	Brookfield viscometer
Spreadability	16.5 ± 0.5 seconds	Time to separate slides
Homogeneity	Excellent	Smooth texture on tactile and visual check
Washability	Easily washable	No residue on washing
Greasiness	Non-greasy	Subjective panel assessment
Irritancy	Non-irritant	Patch test, no redness/edema
Stability (Accelerated)	No phase separation or color change	40°C, 75% RH for 3 months

Microbial Load	Within acceptable limits (<100 CFU/g)	Microbial limit test
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Conclusion

The formulated herbal cream containing Aloe vera gel, Neem extract, and Turmeric extract demonstrated significant multipurpose benefits including moisturizing, anti-inflammatory, antimicrobial, and antioxidant properties. Each herbal ingredient contributed distinct and complementary activities that enhanced overall skin health and healing potential. The cream showed desirable physical characteristics such as smooth texture, appropriate pH for skin compatibility, good spreadability, non-greasiness, and stability under room temperature conditions. Safety evaluations indicated no irritation upon topical application, supporting its suitability for various skin types.

In conclusion, this herbal cream formulation provides a natural, safe, and effective alternative to synthetic topical products. Its multipurpose action and stability underscore the utility of combining Aloe vera, Neem, and Turmeric extracts in an optimized oil-in-water cream base for skin care applications. The study supports wider use of herbal actives in cosmeceutical and therapeutic creams, meeting current consumer demand for natural and environmentally conscious products with proven efficacy.[30][31][32][33][34]

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